

Title: *Neutral Rain on the Earth's Upper Atmosphere*

Cluster: *Heliophysics Theory Program*

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- **Neutral Rain on the Earth's Upper Atmosphere**

Simulations with USU's 3-D, time-dependent model of the neutral and ion polar winds indicate that substantial neutral and ion fluxes are created in the polar regions during geomagnetic storms at altitudes above ~ 500 km, and these results are consistent with NASA satellite measurements (right panel). As the H^+ and O^+ ions drift upward in response to storm heating, they are accelerated to velocities as high as 10-20 km/s for H^+ and 3-5 km/s for O^+ . Charge exchange of the upflowing ions with the background neutral atmosphere (thermal and hot geocoronal neutrals) acts to produce energetic streaming H and O atoms. Both H^+ and H have sufficient energy to escape, but O^+ and O eventually follow parabolic trajectories back to Earth. Likewise, at middle and low latitudes, the H^+ and O^+ ions that stream along closed B-field lines from one hemisphere to the other charge exchange with the background neutral atmosphere and this also results in downward streaming neutrals (left panel). The global distribution of downward streaming O atoms corresponds to a continuous *neutral rain on the Earth's upper atmosphere*, and this could be an important source of momentum and energy for the thermosphere.

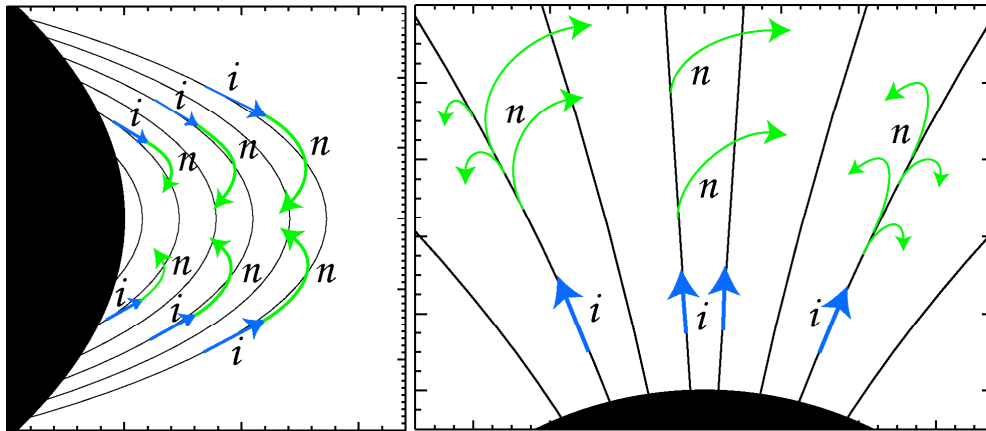


Fig. Not to scale. Up-flowing ions in the plasmasphere (left) and polar wind (right) charge exchange with the background neutral atmosphere and the resulting downward flux of oxygen atoms provides momentum & energy for the thermosphere.